Primary Erosion & Sediment Control Plan

Holtze Development Area

Department of Planning, Infrastructure and Logistics

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TABLE OF CONTENTS

Tables

Figures

Appendices

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1 INTRODUCTION

The NT Government has developed a land supply strategy to meet demand for serviced land, particularly dwelling lots, as a result of projected and incentivised population growth. For the Greater Darwin region there is currently a 20-year strategy to supply serviced land to meet the near- to medium-term housing demand. Based on current forecasts, land releases for development are required as early as 2024. The Greater Holtze area has been identified as a beneficial land development area for the following reasons:

- Its vicinity to existing urban communities allowing for community interconnectivity;
- The requirement to ensure sustainability of the existing social infrastructure in Palmerston (currently under-utilised); and
- The cost efficiencies associated with enabling infrastructure to support new development.

The Greater Holtze area is comprised of four potential development areas – referred to as Holtze, Kowandi, Holtze North and Howard Springs North (Figure 1-1). Holtze has been identified as the first preferred area for subdivision due to its vicinity to existing services and the Palmerston community. Holtze, herein referred to as the Proposal area, is located 1.8 km north of Palmerston CBD and covers two vacant Crown Land lots; Section 4231 and 4229 Hundred of Bagot and one freehold tenure, Portion 2295 (Figure 1-2).

As part of the referral process for the Proposal area, assessing the environmental impacts associated with the proposed development, the Department of Infrastructure, Planning and Logistics (DIPL) have engaged EcOz Environmental Consultants (EcOz) to develop the Primary Erosion and Sediment Control plan (ESCP) associated with the proposed development.

1.1 ESCP scope and purpose

This Primary ESCP has been prepared and reviewed by consultants who have completed an advanced erosion and sediment control course and are registered as Certified Professionals in Erosion and Sediment Control – In Training (CPESC-IT). The scope of the ESCP incorporates the following elements in accordance with accepted best practice erosion and sediment control:

- Inclusion of an overarching erosion risk and hazard assessment.
- Identification of areas vulnerable to erosion, and receiving waters.
- Details of measures to be implemented to effectively manage erosion, and potential sediment mobilisation associated with the project activities.

The purpose of this ESCP is to:

- Ensure stormwater is managed to protect downstream water quality.
- Prevent erosion and potential sedimentation associated with site activities.
- Provide general drainage, erosion and sediment control practices for the project.

This ESCP has been prepared to provide a best-practice framework for implementation of effective erosion and sediment control over the construction period of the development. ESC recommendations and designs provided are consistent with the International Erosion Control Association *Best Practice Erosion and Sediment Control* (IECA 2008) publication. This plan will be used to inform preparation of Progressive ESCP's that provide detailed site-specific controls relevant to the current operational phase and level of erosion risk (i.e. wet/dry season).

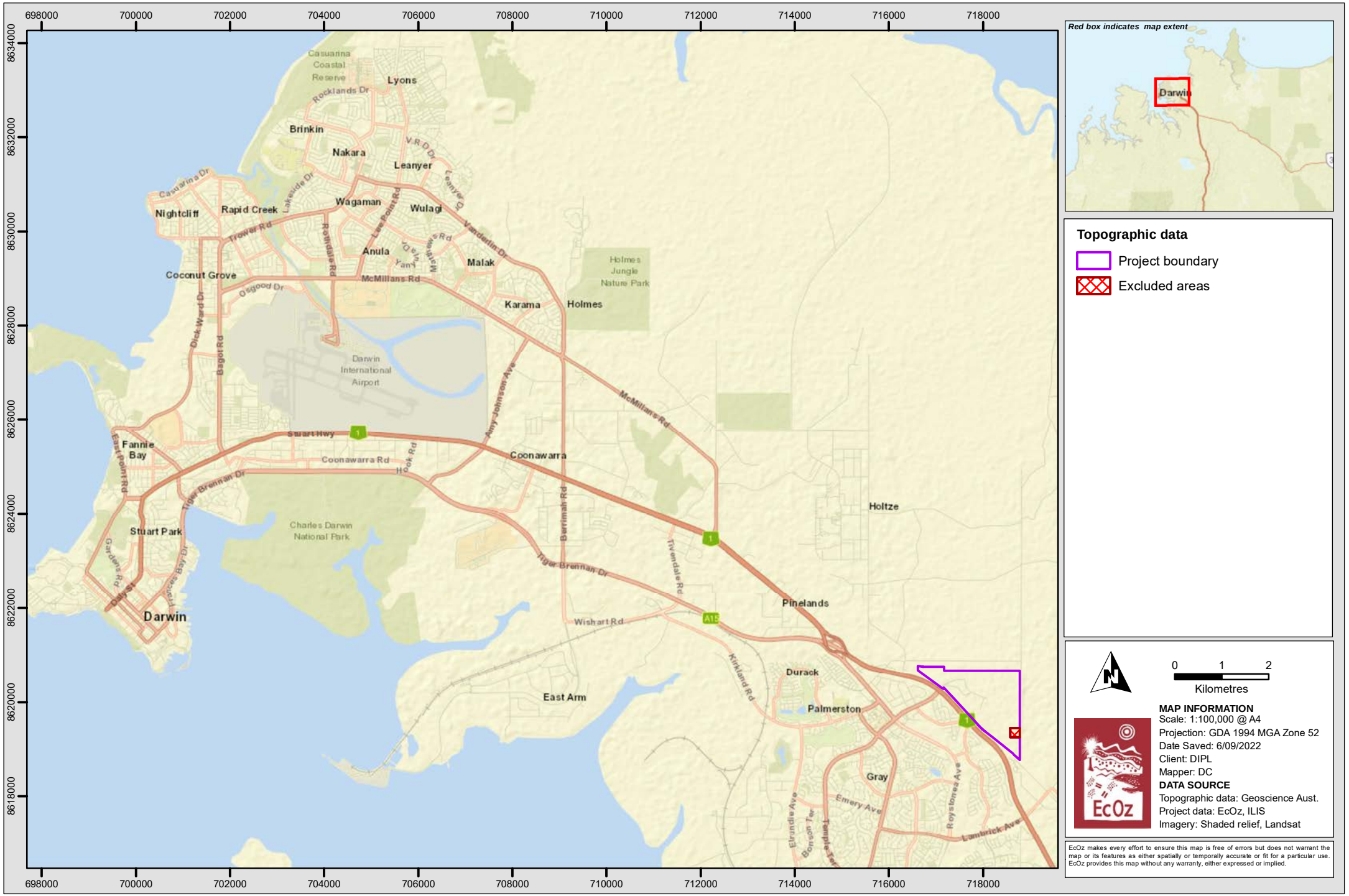

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Figure 1-1. Map of Holtze and its surrounds

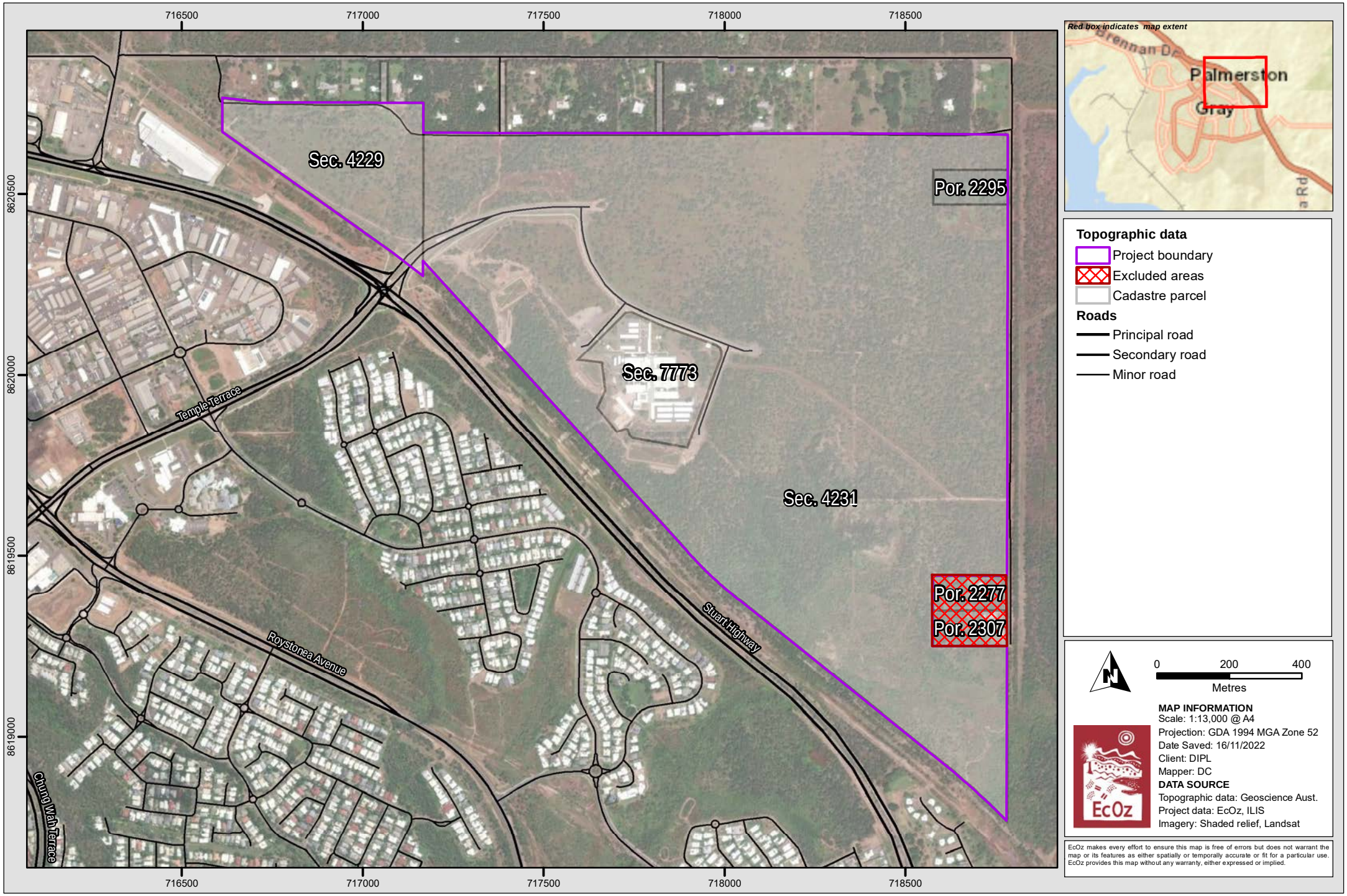

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Figure 1-2. Map showing the Proposal area

2 PROJECT DETAILS

The Proposal involves the clearing of approximately 116 ha for development of the Holtze Development Area, including:

- Holtze Land Release;
- Territory Reserve Parcel;
- The Palmerston Health Precinct; and
- Other residual future urban development areas west of Taylor Road.

Works include construction of enabling and subdivision infrastructure, comprising sewerage, water supply, power, communications, roads, drainage and social infrastructure.

Following initial enabling infrastructure works, the land will be subdivided and released for development of residential, commercial, public space and community purposes.

2.1 Footprint and site layout

2.1.1 Development zones

The Proposal area has been divided into development precincts, which are shown in Figure 2-1. The Holtze Land Release and Palmerston Health Precinct include subdivided lots, internal roads, footpaths, drainage and services.

An open space and drainage zone will remain on the southern half of the development footprint. Clearing of some vegetation will be required for construction of the drainage infrastructure. The residual open space will remain as natural vegetation for community recreational use.

The area north of the proposed Gunn Point Road (bordering with the existing rural properties on Wallaby Holtze Road) is not proposed for development as part of the Proposal. This area is to remain as a buffer zone to the Rural Living area until future land use plans are adopted to allow for further development. The area may require minor disturbance along drainage easements in the short term for installation of stormwater infrastructure.

This undeveloped area will remain under the management of Crown Lands until land uses change and further development is planned.

The key components and disturbance footprint of the Proposal are presented in Table 2-1.

Table 2-1. Summary of key proposal components

	Component	Footprint	Estimated clearing extent
Main development area			
Development infrastructure	Urban development area (residential, commercial and community uses)	76 ha	100%
	Sub-arterial/ Collector roads	7 ha	100%
	Open space and drainage	65 ha	10%
Other	Remaining area (north of the proposed Gunn Point Arterial)	45 ha	5%
Total development area		193 ha	91.5 ha
Existing development disturbance (hospital site)		9 ha	-
Total disturbance following development			100.5 ha

	Component	Footprint	Estimated clearing extent
Ancillary works			
Enabling infrastructure	Sewer main pipeline	11.85 ha (5,925 m, 20 m corridor)	5 ha
	Water main pipeline	8 ha (4,000 m, 20 m corridor)	6.8 ha
	Water booster pump station and groundwater storage tank	9 ha	9 ha
	Mains power transmission line and access road	0.7 ha (680 m, 10 m corridor)	0.7 ha
	Temporary stormwater management basins	3 ha	3 ha
Ancillary areas disturbance			24.5 ha
Total Proposal area clearing required			**116 ha**
Total Proposal area disturbance footprint			**125 ha**

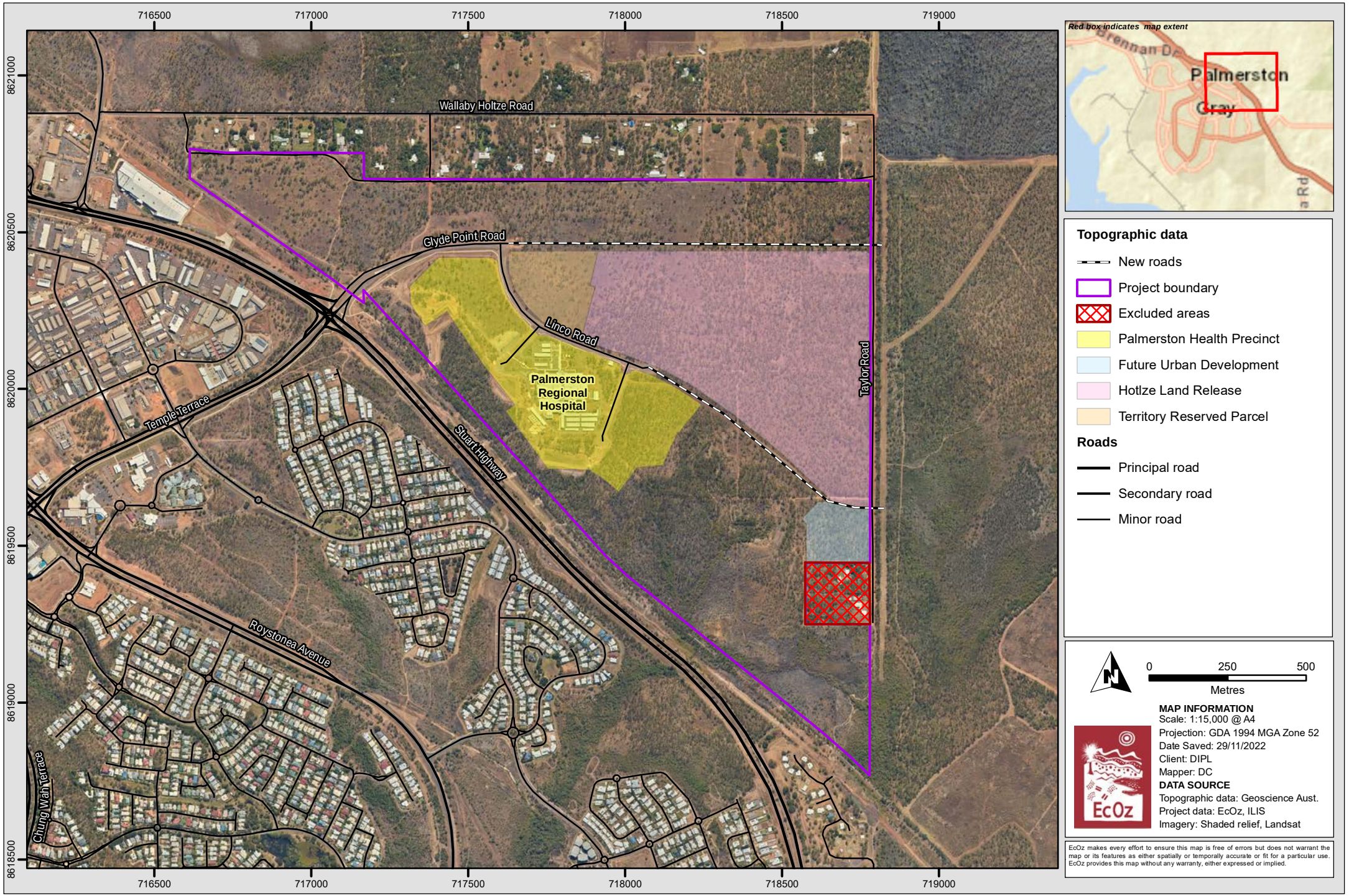

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Figure 2-1. Map of Proposal development precincts

2.2 Proposal schedule and staging

The scheduled components relevant to this proposed development is detailed in Table 2-2.

Table 2-2. Forecasted Holtze Proposal – key deliverables

Phase	Deliverable
Construction	Q2 2023 – Q4 2025: construction of enabling infrastructure and early development works (i.e. land clearing) Q4 2024: first staged release of titled lots, construction works within subdivision
Operation	Q4 2024 onwards – occupancy to follow construction of housing in first land release

2.3 Construction activities

Construction activities will include:

- Site establishment, fencing, installation of temporary construction infrastructure (site offices, cribs sheds etc.) and installation of environmental controls (i.e., erosion and sediment controls)
- Clearing and grubbing
- Construction of new roads to service the area (earthworks, pavement installation, sealing works)
- Stormwater drainage installation, including detention basins
- Installation of services including water and sewer mains, electrical reticulation and street lighting, and telecommunication
- Building construction works (foundations, structural work, internal services, fit-out, painting)
- Landscaping

3 SITE CHARACTERISTICS

3.1 Climate

The Proposal area lies within the Wet-Dry tropics of the NT. The Wet season is typically November to April, and the Dry season May to October. Almost all rainfall occurs during the Wet season, with an average annual rainfall of 1,887 mm (BoM station 014149, Howard Springs Nature Park). The wettest months are typically January and February. Typically, no rain falls during the Dry season months of June, July and August. Wet season rainfall can be highly variable with the lowest average of 645 mm (1975) and highest average 2,881 mm (1998).

Average annual potential evaporation in the Greater Darwin area is 2,340 mm, which exceeds average annual rainfall by 450 mm. The highest potential evaporation occurs between September and October, and lowest between February and March. Average monthly rainfall exceeds evaporation for only four months (December – March). Figure 3-1 presents the average monthly rainfall for the Howard Springs Nature Park (BoM site #014149, less than 8 km from Holtze).

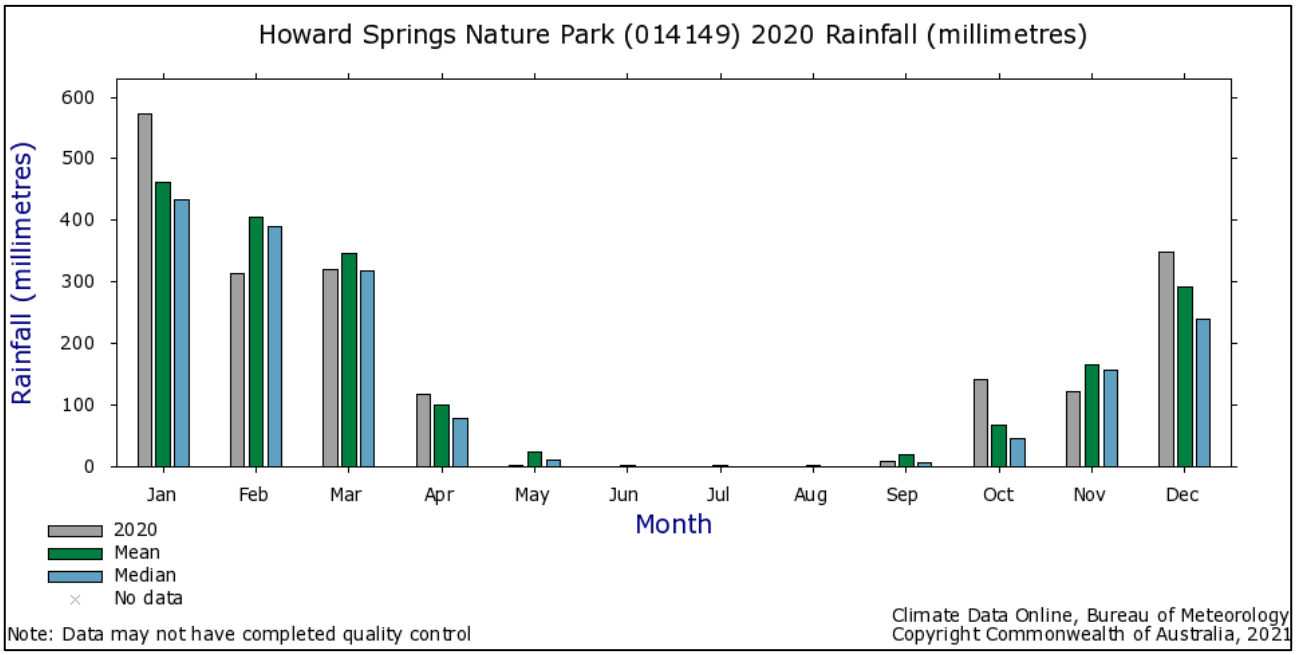


Figure 3-1. Average and median monthly rainfall as well as 2020 rainfall for Howard Springs Nature Park (1964-2021)

3.2 Topography

Most of the Proposal is located on flat to gently undulating upland surfaces, with slopes generally ranging from 0 - 1%, with some sections of moderate slopes of approximate 1 - 2.5%, largely located in the east and north-west portions of the site. In the southern portion of the Proposal area closer to the Stuart Highway, there are steep to moderate slopes of approximately 5% +, present in the transition zone between the upland surfaces and the drainage lines at the headwaters of Mitchell Creek.

3.3 Geology and soils

Figure 3-2 shows the local geology and Table 3-1 provides accompanying geologic unit descriptions. The only recognisable rock outcrop within the Proposal area is an outcrop of Proterozoic sedimentary rocks

belonging to the Burrell Creek Formation, located in the south-eastern portion of the Proposal area. These are exposed in an area previously used for small-scale extraction of rock aggregate (i.e., a borrow pit). The northern and central portions of the Proposal area comprise an upland surface of laterite, and the lower slopes and drainage lines in the south-eastern portion comprise quaternary deposits of slope wash, colluvium and fluvial gravel, silt and sand.

Table 3-1. Geologic unit descriptions for the Holtze Proposal area

Map Symbol	Unit Age	Unit Name	Lithological Description
L	Tertiary	NA	Laterite gravel (pisolitic and nodular); duricrust/ferricrete
Qc	Quaternary	NA	Slope wash, sandy flood plains, gravel, sand, silt, colluvium
-Pfb	Proterozoic	Burrell Creek Formation	Siltstone, shale and phyllite, quartz veins, coarse quartz sandstone, quartz arenite, arkose, quartz pebble conglomerate

A land unit is a reasonably homogenous part of a land surface, distinct from surrounding terrain with consistent properties in landform, soil and vegetation (Jessop & King 1997). As such, each land unit has a characteristic pattern on aerial imagery. Land unit mapping by Fogarty et al. (1984) at a scale of 1:15,000 was revised in 2014 by EcOz after a ground-truthing survey was undertaken (EcOz 2021). Seven land units occur within the Holtze Proposal area (see Table 3-2 and Figure 3-2). In general, the site consists of flat to gently undulating upland surfaces (land units 3a, 3b and 3c) that slope steeply towards the Stuart Highway along the southern boundary of the site (land unit 1c). The lowland drainage areas (land unit 5b1) comprise the upper reaches of the Mitchell Creek catchment.

Inspection of historical aerial imagery indicates that the northern portion of the proposal area – approximately 90 ha – was cleared in the late 1960s and now comprises re-growth vegetation.

Table 3-2. Land units within the Proposal area

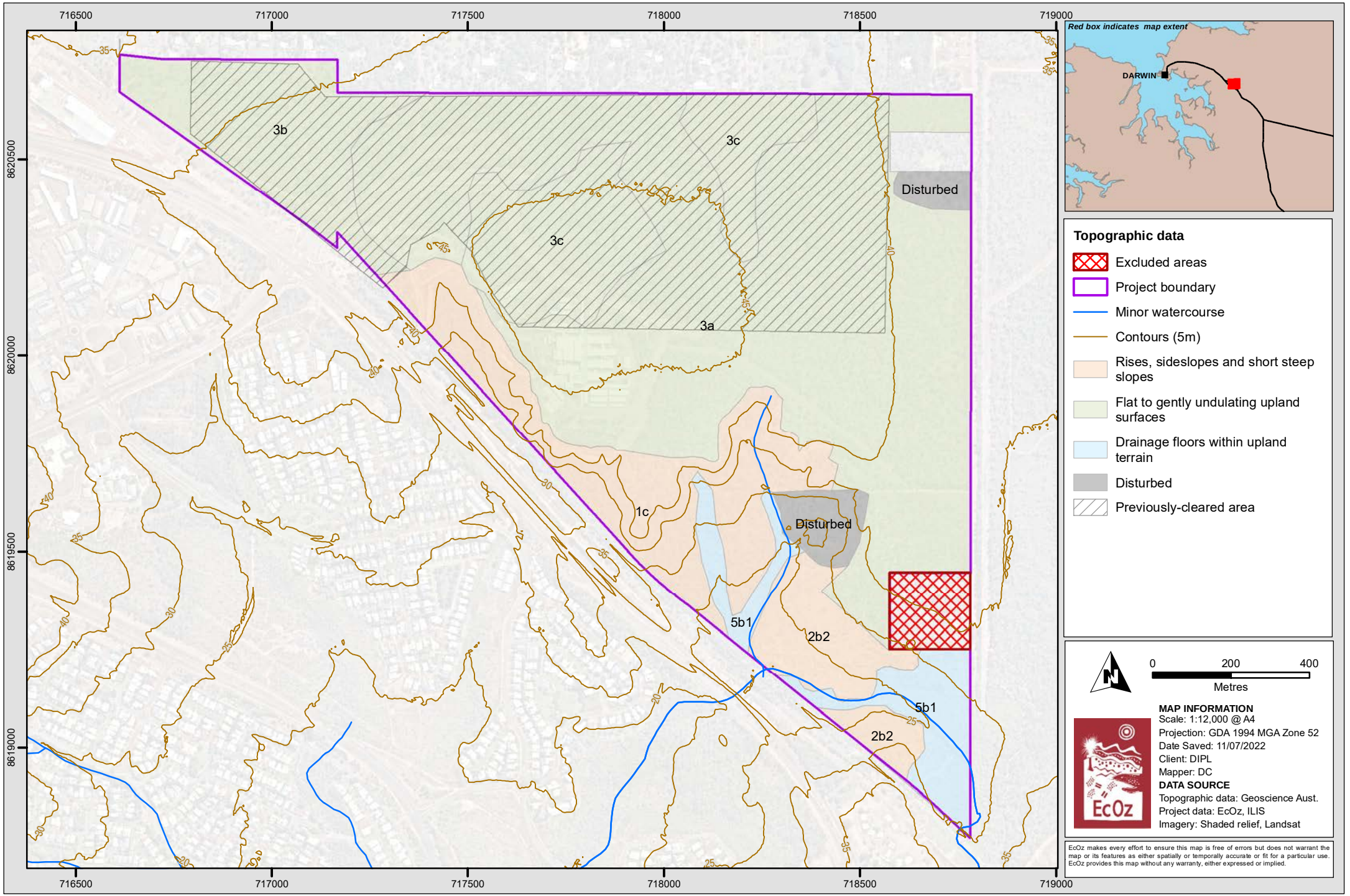
No.	Landform	Soil	Vegetation	Slope	Drainage
1c	Rises and short steep slopes	Organosols	Woodland of *E. tetrodonta, E. miniata*, over *S. intrans* and *H. triticeus*	5 - 15%	Nil to low level of seasonal soil waterlogging
2b2	Side slopes	Hydrosols	Low woodland of *C. latifolia, E. tectifica* and *Grevillea pteridifolia* over *H. triticeus*	2 - 5%	Moderate level of seasonal soil waterlogging
3a	Flat to gently undulating upland surfaces	Brown Kandosols	Open forest of *E. tetrodonta, E. miniata* +/- *Erythrophleum chlorostachys* over *S. intrans* and *H. triticeus*	0 - 2%	Nil to low level of seasonal soil waterlogging
3b			Open woodland of *E. tetrodonta, E. miniata* +/- *C. bleeseri*, over *S. intrans* and *H. triticeus*	0.5 - 2.5%	
3c			Low open woodland of *C. latifolia* and *E. tectifica* over *S. intrans* and *H. triticeus*	0 - 2%	
5b1	Drainage lines with upland terrains	Hydrosols	Open woodland/shrubland of *Grevillea pteridifolia* and *Pandanus spiralis* over mixed grasses	1-4 %	Very slow. High level of seasonal soil waterlogging

3.4 Hydrology

The Proposal area lies across the catchments of the Howard River and the Elizabeth River. Catchment boundaries and surface water drainage lines are shown in Figure 3-2.

The headwaters of Mitchell Creek flow through the south-eastern corner of the Proposal area. Mitchell Creek is a minor stream that flows from north to south and discharges into the Elisabeth River which flows into Darwin Harbour, approximately 7.5 km south of the Proposal area. Flows within the creek typically occur between December and June, with periods of little to no flow occurring in the mid to late Dry season, and prior to Wet season rainfall.

The northern part of the Proposal area is located within the Howard River catchment, although there are no defined drainage lines that would be directly affected by the development. The headwaters of King Creek are located within 1 km north-east of the Proposal area from where a small portion of water from the Proposal area naturally drains through swampland to the north and into Shoal Bay.



Path: Z:\01 EcOz_Documents\04 EcOz Vantage GIS\EZ20050 - Holtze NOI\Project files\Figure 2-1. Map of land units within Holtze.mxd

Figure 3-2. Map showing land units and catchments of the Proposal area

4 EROSION HAZARD AND RISK ASSESSMENT

Erosion risk refers to the evaluation of the "risk" of soil erosion when consideration is given to both the degree of erosion (consequence) and the likelihood of the erosion occurring. Best practice erosion control depends on the likelihood and intensity of expected wind or rainfall and therefore requires an assessment of erosion risk utilising information such as mean monthly rainfall data and mean monthly erosivity (i.e low, medium and high) (IECA, 2008).

Erosion hazard is assessed using the Revised Universal Soil Loss Equation – RUSLE (IECA 2008). This is used to predict the long term, average, annual soil loss from sheet and rill erosion under specified management conditions. This method was adopted due to its capability in being able to provide specific detail around estimated soil loss volumes and risk ratings for each of the Proposal's components.

4.1 Erosion hazard (using RUSLE)

Erosion hazard considers surface area, land slope, soil type and land use in addition to raindrop impact. Potential soil loss is determined from the Revised Universal Soil Loss Equation – RUSLE (IECA 2008). This is commonly used to predict the long term, average, annual soil loss from sheet and rill erosion under specified management conditions. The RUSLE is represented by the following equation:

A = R * K * L * S * P * C, where:

A: estimated soil loss (tonnes/ha/yr)

R: rainfall erosivity factor

K: soil erodibility factor

LS: slope length/gradient factor

P: erosion control practice factor

C: ground cover and management factor

Table 4-1. Summary of RUSLE inputs

Factor	Description	Value	Comment
A	estimated soil loss (tonnes/ha/yr)	variable	As calculated per catchment
R	rainfall erosivity factor	15,724	Adopted from Darwin Harbour Advisory Committee Research Group for Darwin Airport (Section 4.1.1)
K	soil erodibility factor	0.043	0.043 adopted – worst case scenario (Section 4.1.2)
LS	slope length/gradient factor	variable	Based on catchment characteristics. (Section 4.1.3)
P	erosion control practice factor	1.3	Construction phase condition (Section 4.1.5)
C	ground cover and management factor	variable	Based on proposed surface cover. (Section 4.1.4)

The following paragraphs outline each of the components that contribute to the RUSLE equation.

4.1.1 Rainfall erosivity (R–factor)

The rainfall erosivity factor (R-factor) is a measure of the ability of rainfall to cause erosion. It is a product of two components: total energy (E) and maximum 30-minute intensity for each storm (Landcom 2004). The R-factor is an input component in measuring estimated soil loss using the RUSLE calculation. In cases where the R-factor is not made available by IECA or the Darwin Harbour Advisory Committee Research Group, the following annual R-factor equation can be used.

$$R = 164.74\ (1.1177)^{S}\ S^{0.6444}$$

Where:

$$S = 2\ yr\ ARI, 6hr\ event\ (0.5\ EY\ design\ rainfall)$$

The adopted annual R factor for the project is 15,724; provided by the Darwin Harbour Advisory Committee Research Group to better reflect the rainfall erosivity of the NT.

4.1.2 Erodibility (K-factor)

The K-factor is a numerical representation of the ability of soils to resist the erosive energy of rain (IECA 2008). Soil texture is the principle component affecting K, but soil structure, organic matter and profile permeability also contribute. In the absence of site specific soils information, a K-factor of 0.043 has been adopted for all areas impacted by construction. This represents the highest observed soil erodibility around the site. K-factors can be identified from IECA 2008 *Table E5 – Typical K-factors based on Unified Soil Classification System*.

4.1.3 Slope (LS–factor)

The LS-factor describes the combined effect of slope length and slope gradient on soil loss. The Proposal area is characterised by slopes from 0.5 – 15 % (refer to Section 3.3). This represents the topography at the commencement of project construction, with ongoing earthworks during construction and completion to significantly affect both slope gradient and slope length. For roads, slopes will reduce, or remain similar to the natural landform (ie. < 4 %).

4.1.4 Cover factor (C–factor)

The cover and management factor is a measure of the level of soil surface protection provided by various groundcovers. It can include a proportion of vegetation, rock, hardstand, paving, soil binders, matting and associated non-erodible material. The C-factor for the proposal will vary depending on stabilisation and management of surfaces exposed by construction and operation and is to be updated progressively within each Progressive ESCP.

Table 4-2. Adopted C-factors

Surface type	% cover	C-factor
Concrete, bitumen	100	0
Vegetation (highly variable)	25 - 80	0.37 – 0.025
Soil stabiliser (eg. Vital Bon-Matt HR or Bon-Matt RDS (S72))	80	0.025
Rock	80-100	0.025 - 0
Competent gravel/soil (eg. roads)	25	0.37
Bare soil, erosive surface	0 - 20	1 - 0.44

4.1.5 Erosion control practice factor (P–factor)

The P-factor measures the combined effect of all support practices and management variables. It also represents structural methods for controlling erosion (IECA 2008). The nominated P-factor for all areas within the proposal without permanent stable groundcover is 1.3 (based on the default construction phase condition).

4.2 Estimated soil loss

Estimated soil loss from the site can be categorised into seven distinct categories, which outline the volume of soil lost per year in tonnes per hectare. The soil loss classes as identified by IECA Table 3.1 are as follows:

Table 4-3. Soil loss class (IECA, 2008)

Erosion hazard	Soil loss (tonnes/ha/year)	Soil Loss Class
Very Low	0 - 150	1
Low	151 - 225	2
Low to Moderate	226 - 350	3
Moderate	351 - 500	4
High	501 – 750	5
Very High	751 - 1500	6
Extremely High	>1501	7

Potential soil loss calculations and associated erosion hazard for defined Proposal areas are provided within Table 4-4. Nominated project components reflect the proposed site layout.

Table 4-4. Soil loss and erosion hazard

Parameter	Land unit & final proposed land use						
	Development areas			Passive Open Space			
	3a	3b	3c	1c	2b2	5b1	Disturbed area
Undisturbed (ha)	0.0	0.0	0.0	26.033	10.9	11.1	5.3
Disturbed (ha)	104.729	18.987	22.562	0	0	0	0
Total catchment area (ha)	104.73	18.99	22.56	26.03	10.89	11.12	5.28
Rainfall erosivity (R)	15724	15724	15724	15724	15724	15724	15724
Soil erodibility (K)	0.043	0.043	0.043	0.043	0.043	0.043	0.043
Slope length (L)	200	200	200	200	200	200	200
Slope gradient (S)	2	3	2	15	5	4	15
Length/gradient (LS)	0.58	1.00	0.58	9.91	2.00	1.47	9.91
Erosion control practice (P)	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Ground cover in disturbed	20	20	20	90	90	90	90

Parameter	Land unit & final proposed land use						
	Development areas			Passive Open Space			
	3a	3b	3c	1c	2b2	5b1	Disturbed area
catchment (%)							
Ground cover in disturbed catchment (C)	0.44	0.44	0.44	0.01	0.01	0.01	0.01
Potential Soil Loss							
Soil Loss (t/ha/yr)	224	387	224	87	18	13	87
Soil Loss (m^3/ha/yr)	173	297	173	67	14	10	67
Soil Loss Class	2	4	2	1	1	1	1
Erosion Hazard	Low	Moderate	Low	Very Low	Very Low	Very Low	Very Low

4.3 Erosion risk

Erosion risk refers to the evaluation of the "risk" of soil erosion when consideration is given to both the degree of erosion and the likelihood of the erosion occurring (IECA 2008). In the absence of a site specific risk assessment procedure, erosion risk rating is determined from using mean erosivity data from the Darwin Harbour Advisory Committee Research Group Ratings for Darwin Airport (Table 4-6).

The erosion risk rating system is taken from *IECA* Table 4.4.1, where:

Table 4-5. Erosion risk rating system (IECA, 2008)

Rating	Average monthly erosivity (R-factor)
Very Low	0 to 60
Low	61 to 100
Moderate	101 to 285
High	286 to 1500
Extreme	> 1501

Erosion risk ratings range from high to extreme for the wet season (Dec – Mar), with dry season risk moderate to very low (Apr – Nov).

Table 4-6. Monthly erosion risk rating for Darwin

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Erosivity (mm)	4496	3512	2826	808	160	15	5	47	80	472	948	2355
Rating	Extreme			High	Moderate	Very Low			Low	High		Extreme

4.4 Erosion and sediment control requirements

Recommended erosion and sediment control measures are based upon the relationship between erosion hazard (as determined from Table 4-4) and erosion risk (Table 4-6). The Darwin climate, with a reliable and prolonged dry season (May to September), provides a low risk of erosion from rainfall throughout these months, although wind erosion potential (dust) is significant.

It is essential that erosion and sediment control measures are fully implemented prior to the 1st October, in preparation for the wet season, and corresponding high to extreme erosion risk from October to April. Table 4-7 summarises erosion and sediment control requirements for all stages of project construction and operation across a full calendar year. Typical measures to be implemented during the project are discussed in Section 5 below, with specific design, timing and location to be provided within Progressive ESCPs and associated engineering drawings.

Table 4-7. Erosion risk and ESC requirements during construction

Erosion Risk Rating	Months	Erosivity	Erosion & Sediment Control Requirements
Negligible (Very Low)	Jul Aug Sep	5 47 80	• Sediment control to be installed around areas of erosion risk prior to 1st October (wet season commencement). • Dust suppression to be implemented as required
Moderate	May June	160 150	• Sediment control to be installed around areas of erosion risk prior to 1st October (wet season commencement). • Areas of erosion risk protected (min 75% cover) within 10 days completion (or cessation) of earthwork activities [1] • Sediment control installed & maintained • Dust suppression to be implemented as required
High	April October November	808 472 948	• Areas of erosion risk protected (min 75% cover) within 10 days completion (or cessation) of earthwork activities [1] • Sediment control installed & maintained • Dust suppression to be implemented as required
Extreme	January February March December	4496 3512 2826 2355	• Areas of erosion risk protected (min 80% cover) within 5 days completion (or cessation) of earthwork activities [1] • Sediment control installed & maintained • Dust suppression to be implemented as required
Notes:	[1] Areas of erosion risk may be protected using the following types of cover: hardstand (concrete, bitumen, gravel, buildings), soil binder (polymer), placement of mats, blankets (e.g. geotextile, jute) or vegetative cover (min 75% for all areas, with min 90% for drainage channels).		

5 EROSION AND SEDIMENT CONTROL MEASURES

Erosion and sediment control measures required during construction and operation have been derived based on the site erosion hazard and risk. Conceptual details of the controls are provided in the sections below based on the current level of design detail. The process for development of progressive ESCPs that will provide further detail on site-specific controls is also described.

5.1 Progressive ESCPs

As construction and operation activities advance, specific up-to-date details on the location and installation of ESC measures will be provided within Progressive ESCPs. Typically, this will include the following construction stages/situations where erosion risk rating is assessed as high to extreme (i.e. October – April):

- Where a new stage of construction works are commenced and/or controls require alteration due to change in work practices (e.g. clear & grub, topsoil strip, bulk earthworks, final stabilisation).
- Controls require alteration due to change in seasonal conditions (e.g. dry season vs wet season).
- Installation of road, drainage and waterway crossings.
- A change in the project design occurs that potentially impacts on ESC requirements.
- The desired outcome (e.g. protection of receiving environments) is not being achieved.
- Clear details of roles and responsibilities of all involved implementing the ESCP (including plan development, changes, inspections, maintenance and auditing)
- Provide clear details for rehabilitation of disturbed areas.

Where required, Progressive ESCPs will be developed with site personnel, when specific site conditions can be assessed and appropriate control measures determined. All Progressive ESCP's are to be consistent with this Primary ESCP, with specific measures in accordance with IECA guidelines, project approvals and associated documentation.

5.2 Site preparation

Site preparation is a key component of an ESCP and a large component involves protection and clearing of vegetative material.

5.2.1 Vegetation clearing

Vegetation clearing (where required) is to be undertaken in accordance with applicable approvals and will require a Progressive ESCP to cover these works. Clearing methodology to be included in the ESCP should cover the following:

- Clearing activities to be implemented consistent with the *NTG Land Clearing Guidelines* (DENR 2019)
- Vegetation clearing shall be kept to the minimum amount necessary to allow access and/or approved activities.
- Areas of protected vegetation and significant areas of vegetation which are to be retained, must be clearly identified prior to the commencement of clearing

- Approved areas for native vegetation clearing to be clearly identified.
- Previously cleared areas shall be utilised where possible for laydown and turn around points.
- Disturbance to natural watercourses and associated riparian zones must be limited to the minimum practicable.
- Cleared vegetation is to be retained and reused in site rehabilitation wherever possible.

5.2.2 Buffers

DIPL's contractor will be required to maintain riparian buffer strips around impacted drainage features to protect riparian habitats and vegetation (where required). Buffer distances are as per the *NT Land Clearing Guidelines* (DEPWS 2021) and included in Table 5-1.

Table 5-1. Riparian buffer widths (DEPWS 2021)

Riparian class	Stream order	Min buffer width (m)	Measured from
Drainage depression	NA	25	The outer edge of the drainage depression, which is the extent of the associated poorly drained soils and associated vegetation.
Intermittent streams	1st	25	The outer edge of the riparian vegetation or levee (whichever is greater). If braided channels are present, the edge of the outer-most stream channel.
Intermittent streams	2nd	50	As above
Creeks	3rd & 4th	100	As above
Rivers	5th or higher	250	As above

The adoption of the buffer distances, as listed in Table 5-1, will have the following benefits:

- Reduce velocity of runoff entering drainage depressions and watercourses via sheet flow
- Promoting capture of sediment
- Reduce erosion within riparian areas (wind and water)
- Provide network of linked habitats and wildlife corridors
- Provision of shade and amenity

5.3 Drainage control

Drainage controls include measures for the diversion of 'clean' stormwater runoff around and through the site; and the diversion of 'dirty' site stormwater runoff to enable treatment of sediment prior to release offsite, as defined below:

Clean water:

Water that either enters site from an external source and has not been further contaminated by sediment within site; or water that has originated from the site and is of such quality that it does not need to be treated in order to achieve the required water quality standard (IECA 2008). Site clean water constitutes surface runoff from areas of non-erodible cover, including vegetation, hardstand, soil binder, mats or blankets (e.g. geotextile).

Dirty water:

Water not defined as clean, thereby requiring treatment with appropriate controls prior to release from site (IECA 2008).

Temporary drainage controls installed as part of construction will enable management of stormwater within work areas. Drainage controls will perform the following functions:

- Enable diversion of 'clean' up-slope run-on water either around or through the site at non-scouring velocities.
- Enable collection of 'dirty' runoff generated within construction areas and the delivery of this water to an appropriate sediment control measure.
- Minimise the risk of soil erosion caused by site-generated flows within the project, through the use of 'intermediate' flow treatment and release points.
- Control of the flow velocity, volume and location of water passing through the project at drainage line and waterway crossings.

Controls proposed for the site include:

- Topsoil bunds - to prevent ingress of upslope clean water into the Proposal area, direct site water to sediment basins.
- Catch drains – for collection and diversion of sheet flow across a slope or around soil disturbances.
- Diversion channel – for diversion of large concentrated flows.
- Flow diversion bank – flow diversion at base of fill slopes; cross drainage on unsealed roads.
- Chutes – discharge of concentrated flows down steep slopes.
- Rock Check Dams – velocity control device within concentrated flow channels. Also used as sediment control.
- Culverts.

Typical designs are provided within Appendix B and applicable engineering plans (which are to be developed).

5.4 Erosion control

Prevention of erosion is the primary approach for the prevention of adverse impacts associated with sedimentation. Construction activities are to be undertaken so as to reduce the duration of soil exposure to erosive forces (wind and water), either by holding the soil in place or by shielding it. Measures to be used include a variety of construction practices, structural controls and vegetative measures aimed at managing runoff at a non-erosive velocity, and the protection of disturbed soil surfaces.

The specific measure(s) implemented will be based on seasonal erosion risk and construction considerations. Measures will be documented in the most current Progressive ESCP and based upon IECA guidelines. Proposed controls are listed below:

- Undertaking initial construction in the dry season months as far as schedule allows.
- Minimise disturbance to existing vegetation as far as practical within the Proposal area. Land clearing will be undertaken in accordance with a Vegetation Clearing Procedure, which includes procedures and methods for minimising levels of soil disturbance and impacts to natural drainage pathways.

- Promptly stabilising exposed areas once construction phase has been completed (e.g. protecting topsoil and bunds).
- Protection of soil surface (temporary and permanent) including placement of hardstand surfaces, use of soil binder, vegetation establishment (including mulch), and protection with mats & blankets (e.g. jute, geotextile) where practical.
- Application of dust suppression by wetting of exposed surfaces (water truck), application of soil binder, and/or application of soil cover.

5.5 Sediment control standards

Effective erosion and sediment hazard reduction is best achieved by undertaking initial construction activities during the dry season months (April – October) wherever possible (e.g. roads, bunds, sediment ponds/detention basins)..

Sediment control standards are described below and are based upon the soil loss calculations relevant to the site (Table 4-4). Typical designs are provided within Appendix B, with more detailed designs to be provided as engineering drawings and applicable site-specific Progressive ESCPs.

5.5.1 Type 1 Sediment control standard

Based on the scale of the project and calculated potential soil loss (Table 4-4), the Type 1 sediment control standard applies.

A Type 1 sediment control is typically the minimum requirement for the following scenario:

- Catchment area > 1 ha where soil loss > 150 t/ha/yr

A Type 1 sediment control standard is provided by purpose-built sediment basins, designed to collect and settle sediment-laden water. They generally perform two main functions:

- Rapid settlement of coarse-grained particles (e.g. sand and coarse silt) during all storm events that flow through the basin; and
- Settlement of fine-grained particles that are allowed to pass through the basin under controlled conditions.

This enables sediment basins to reduce turbidity levels of construction runoff water, thereby reducing potential for ecological harm.

Sediment basin design is discussed below in Section 6.

5.5.2 Type 2 sediment control standard

Type 2 and Type 3 sediment controls may be implemented in addition to sediment basins to provide supplementary controls throughout the Proposal area. Specific requirements are to be documented within Progressive ESCPs and engineering plans, taking into account timing (i.e. season) and practicality of control measures.

A Type 2 sediment control is the minimum requirement for the following scenarios:

- Catchment area > 1,000 m^2 and soil loss > 75 t/ha/yr
- Catchment area > 2,500 m^2 and soil loss of 75 – 150 t/ha/yr.

A Type 2 sediment trap will demonstrate the following characteristics:

- Under typical flow conditions (discharge and suspended sediment concentration), is capable of capturing and holding at least 90% of material > 0.14 mm.

- Sufficient sediment retention capacity to capture and hold one month's sediment loss from the catchment
- Designed to maintain its hydraulic and structural integrity under normal site conditions.

Type 2 controls include:

- Rock Filter Dam (RFD) - RFDs are structures formed by the incorporation of geotextile (e.g. A19 bidum®) and a coarse rock filter (40-75 mm nominal diameter).
- Filter Bag/Tube - Filter tubes are geotextile bags through which site runoff is directed to enable filtering and treatment of sediment.
- Coir logs - Coir logs are biodegradable tubes filled with densely packed coconut fibre wrapped in coir netting. They can be used as flow diversion berms or to provide sediment control by providing temporary ponding and filtering of site runoff.
- Mulch berms - Berms of coarse mulch located along the contour. Often incorporate a rock filter dam discharge point.

5.5.3 Type 3 Sediment Control standard

A Type 3 sediment control is the minimum requirement where calculated soil loss is < 75 t/ha/yr. A Type 3 sediment trap will demonstrate the following characteristics:

- Under typical flow conditions (discharge and suspended sediment concentration), is capable of capturing and holding at least 90% of material > 0.42 mm.
- Sufficient sediment retention capacity to capture and hold one month's sediment loss from the catchment
- Designed to maintain its hydraulic and structural integrity under normal site conditions.

Type 3 controls include:

- Rock berms - clean rock may be placed as a perimeter berm to filter sheet flow runoff from site (typical size 75-150 mm).
- Sediment fence - sediment fence may be used in locations where placement of rock berms is not practical (due to access, materials and equipment constraints).

5.5.4 Supplementary sediment control

Supplementary sediment controls are not considered effective to meet the Type 3 classification in isolation but will form an important component of the erosion and sediment control system when implemented as supplementary controls. The following supplementary controls will be implemented where relevant to the project phase and site conditions:

- Grass filter strips
- Check dams
- Stabilised construction exits.

In addition to adopting measures as per IECA Standard Drawings, variations to these may be implemented where it can be demonstrated that they are equally as effective and meet the intent of IECA standards.

5.6 Site stabilisation

Following the completion of construction activities, long-term protection of the site from erosion will be provided by the final constructed infrastructure of the development, as per the applicable engineering plans when developed.

In the context of erosion and sediment control, the following practices will assist in achieving site stabilisation and long-term protection for downstream environments:

- Site preparation and revegetation works are commenced as soon as practicable after completion of each stage of earthworks.
- Topsoil (if required) is managed to ensure preservation of its long-term value (i.e. limits to stockpiling duration, and stockpiling height limits).
- Selected plant species for revegetation are appropriate for site conditions and endemic to local vegetation communities.
- Erosion and sediment controls are to remain in place until minimum 75% self-sustaining groundcover (or equivalent) is achieved for disturbed areas, with minimum of 90% for drainage features.

6 SEDIMENT BASIN DESIGN

At least three sediment basins are required on site to conform with this ESCP. Run off captured within these basins will be re-used within the Proposal area wherever practical (dust suppression etc.), with excess treated runoff to be discharged to the receiving environment. Sediment basin capacity for the project has been developed consistent with IECA guidelines (IECA 2008).

The layout of the development will require bunds to separate external clean runoff from internal site runoff, forming a clear delineation between project site water and external runoff. Discharge requirements, management and monitoring will be addressed in a Water Quality Management Plan (WQMP).

Sediment basins proposed for the site are initially designed as Type D basins, which assume dispersive soils requiring the use of flocculating agent to settle. This is a conservative approach, representing the worst case scenario. With the recent finalisation of *Appendix B – Sediment Basin Design and Operation* (IECA 2008), basin design will be revised prior to implementation, to ensure the most efficient basin configuration is adopted. Final basin location will be subject to final site layout; however, the following criteria is to be met:

- Located to maximise collection of sediment-laden runoff generated within the site
- Not located within waterway of drainage channel
- Located above the 1 in 5 year ARI
- Have suitable access for maintenance
- Placed in close proximity to site perimeter for ease of dewatering.

6.1 Basin capacity

Sediment basin capacity is based on the following design parameters:

- 5 day, 85th %ile rainfall amount for Darwin; 46.2 mm (Table B6, IECA 2008).
- Project catchment areas and potential soil loss (Table 4-4).
- Proposal area runoff coefficients for 100 mm rainfall event:
  - 1 for heavily impacted areas (high traffic, compacted)
  - 0.75 for vegetated or less compacted (Table B7 IECA 2008).

Calculations are provided within Table 6-1. The total required capacity is to be provided by the three sediment basins, with relative proportional volumes to be determined upon final site layout and contributing catchment areas.

Table 6-1. Calculation of sediment basin capacity

	Land units (for areas of proposed residential and community purpose only)		
	3a	**3b**	**3c**
Sediment Storage Zone			
Soil loss (t/ha/yr)	24	2522	606
Soil loss (m^3/ha/yr)	19	1940	467
Annual soil loss (m^3/yr)	377	36272	6438
Sediment basin			
Settling Zone Volume	9332	8639	6376
Sediment storage volume m^3	64	6166	1094

	Land units (for areas of proposed residential and community purpose only)		
	3a	3b	3c
Sediment basin volume requirement (m^3 per work area)	9396	14805	7470
Total sediment pond volume (combined 3 sediment ponds)	35,547 m^3		

6.2 Basin construction

Basin construction is to incorporate the following elements:

- Earth embankments to be certified as structurally sound by geotechnical engineer/specialist.
- Stable inflow system (eg. rock chute).
- Minimum 3:1 length to width ratio (may require internal baffles).
- Primary outlet (eg. siphon, perforated riser) for controlled release.
- Emergency spillway (minimum design storm 1 in 50 year ARI).
- Marker to identify the sediment storage zone depth.

6.3 Basin management

Sediment basins are to be managed as follows:

- Discharged within 5 days of cessation of rainfall (min 25 mm).
- Prior to discharge, water quality to meet project discharge criteria specified in site Water Management Plan (flocculant or coagulant may be required).
- Designed to ensure easy and safe access to dose retained water with flocculants as required.
- Marker peg to be installed to indicate sediment storage capacity.
- Removal of sediment where sediment storage capacity exceeds 50% and disposal/management of sediment so as not to create an erosion or pollution hazard.

6.4 Coagulants & ameliorants

Flocculation of basins will be required where the contained water does not meet discharge criteria standard within five days of cessation of rainfall. The application of a coagulant is to occur within 12 hours of the receipt of runoff producing rainfall. Typically, gypsum (calcium sulfate) is used for this purpose. This requires application across the sediment basin surface (spray or hand cast) at a rate of 32 kg per 100 m^3 of water volume.

There are also a range of anionic polymers which may provide a more effective flocculation option. These are also well suited to flow-activated dosing systems, reducing labour associated with flocculation. Choice of flocculant and dosing methods will be managed adaptively based on monitoring of sediment basin performance over the first wet season of operations.

7 SPECIFIC AREAS AND ACTIVITIES

7.1 Site access

Access track construction will depend upon traffic volume, condition of external road (e.g. paved), potential for sediment tracking from work areas, and access requirements by heavy vehicles.

Access tracks are to be constructed and maintained consistent with the following principles:

- Minimise access track construction to ensure the least amount of site disturbance.
- Access tracks are to be graded to a crown, or with crossfall drainage.
- Watercourse crossings and associated approaches are to be protected from erosion.
- Access to incorporate stabilised exit points.
- Tracks are to be monitored for excessive sediment tracking onto adjacent public road. Where sediment build up occurs on public roads at vehicle exit points, a review of the controls will be undertaken and additional measures may be employed.

7.2 Topsoil & spoil management

Earthworks are to incorporate the stripping and preservation of topsoil for reuse (wherever practical). The depth of topsoil stripping is dependent upon soil type, however ideally the top 50 mm is to be retained separately from other material (contains most of the biological activity and nutrients required for successful rehabilitation). Depth of topsoil stripping will be further assessed on site.

Stockpile sites are to be managed so as not to cause environmental harm as a result of sedimentation. Stockpile sites will be located and constructed consistent with the following principles:

- Avoid placement of stockpiles, where practicable, within 50 m of any drains, drainage lines or other waterways. Where not practicable, specific erosion and sedimentation controls to be implemented.
- Top soil stockpiles are to be < 1.5 m in height. All other stockpiles are to be < 3 m in height.
- Stockpiles are to be protected upslope by flow diversion banks to divert run-on water; and downslope by an appropriate Type 2/3 sediment control measure (eg. mulch berm, sediment fence).
- Long term stockpiles (> 10 days), batters and other erosion sensitive areas shall be adequately stabilised (eg. cover, vegetation, soil binder, water diversion or other) as deemed appropriate.

7.3 Ancillary areas

Ancillary areas include temporary infrastructure required to support the construction program and include site compounds, offices, lay-down areas and access tracks. The erosion and sediment control principles and strategies discussed within this document will equally apply to all ancillary areas. Specific Progressive ESCP's will be developed where additional detail is required for these areas.

8 MANAGEMENT AND IMPLEMENTATION

This plan provides a framework and guidance for managing erosion and sediment issues and risks over the construction period of the development. The sections below document details relevant to implementation of this conceptual ESCP and Progressive ESCP's.

8.1 Responsibilities

Roles and responsibilities for implementation of environmental plans and requirements for the project will be detailed within the referral. The requirement deliver progressive ESCPs will be listed in contractual documents and delivery will be the responsibility of the head contractor on site. Generally, the site HSE Manager (DIPL's contractor) will have overarching responsibility for ensuring ESCP's are current and for monitoring implementation and effectiveness of the site specific controls.

Site supervisors and specific staff will have responsibility for installing and maintaining erosion and sediment controls. Designated staff will also have responsibility for ensuring the effective operation of the sediment dams, including monitoring of water quality to ensure discharge criteria are achieved.

Contractors undertaking the site clearing will be responsible for undertaken the works in accordance with the Vegetation Clearing Procedure in order to minimise erosion risk.

8.2 Training and awareness

All project staff and contractors shall be required to undertake an environmental awareness induction prior to commencement of works on the project. The environmental awareness induction is to be targeted to educate staff and contractors on the project environmental objectives and their individual responsibilities for environmental management. This training is to include ESC requirements, with additional specific training of relevant personnel who have a primary role in supervising, installing and maintaining erosion and sediment control measures.

8.3 ESC installation and maintenance

The installation and maintenance of all ESC measures is to be overseen by a suitably qualified person. Installation is to be consistent with the ESCP and associated progressive ESCPs.

All required temporary erosion and sediment control measures must be fully operational and maintained in proper working order until permanent stabilisation is achieved. If ESCs are observed to have reduced capacity, damage or insufficient effectiveness, they are to be repaired, improved or substituted as follows:

- Identified soil erosion areas are to be resolved as soon as possible, with additional control measures implemented to prevent recurrence.
- Settled sediment must be removed as soon as reasonable and practicable from any sediment basin if:
    - It is anticipated that the next storm is likely to cause sediment to settle above the sediment basin's sediment storage zone; or
    - The elevation of settled sediment is above the top of the basin's sediment storage zone.
- All sediment control devices (other than sediment basins) must be de-silted and made fully operational as soon as reasonable and practicable after runoff-producing rainfall, or if the sediment retention capacity of the device falls below 75% of the design retention capacity (IECA 2008).

- Sediment removed from areas of deposition is to be incorporated within subsoil stockpile areas and/or buried on-site.

Spare materials including geo-fabric, sediment fence material, mulch and rock are to be stored on-site to enable repairs to be conducted within a short timeframe.

8.4 Monitoring & reporting

ESC measures are to be inspected at least weekly during operation; within 24 hrs of expected rainfall; and as soon as reasonably practical after receiving significant rainfall events (i.e. >10 mm in 24 hr period). Visual assessment will be carried out of surface water runoff structures, drainage structures and erosion control structures to ensure they are operating efficiently. An inspection checklist is provided within Appendix C.

Environmental objectives and targets for erosion and sediment control are to be documented in the site EMP. Where monitoring identifies that environmental objectives and targets for erosion and sediment control are not being achieved, corrective actions will be enacted. Where significant erosion and/or major exceedances of water quality triggers are recorded, a CPESC will be engaged to advise on suitable controls.

8.5 Updates and variations

ESCPs are dynamic documents, typically requiring updating as construction and operational stages progress and site characteristics alter. Any alterations to the implementation of erosion and sediment controls within specific areas will be recorded and outlined in progressive ESCPs.

Amendments to the site ESCPs will be undertaken at least every 12 months, or else as triggered under the following scenarios:

- Controls require alteration due to change in work practices or new stage of works is commenced.
- Controls require alteration due to change in seasonal conditions (e.g. dry season vs wet season).
- Changes occur in slope gradients and drainage paths, with their exact form unpredictable before works start.
- A change in the project design occurs that potentially impacts on ESC requirements.
- The desired outcome (e.g. protection of receiving environments) is not being achieved.

9 REFERENCES

(DECC) NSW Department of Environment and Climate Change. (2008). *Managing urban stormwater - soils and construction. Volume 2D Main road construction.* Sydney South

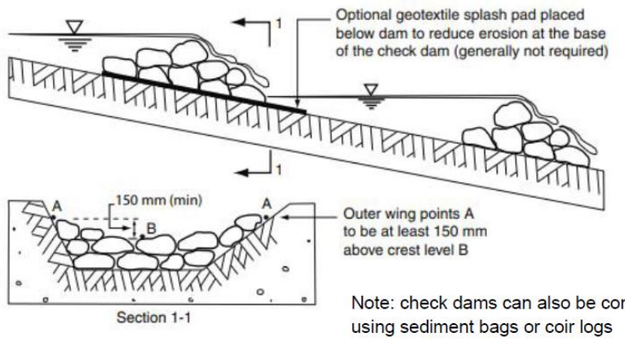
Fogarty, Howe and Dunlop. (1979). *The Land Resources of the Darwin Area* Land Conservation Unit, Territory Parks and Wildlife Commission, Darwin

(IECA) International Erosion Control Association. (2018). Best practice erosion and sediment control. Appendix B – Sediment basin design and operation.

Landcom. (2004). *Managing urban stormwater - soils and construction. Volume 1*. Sydney

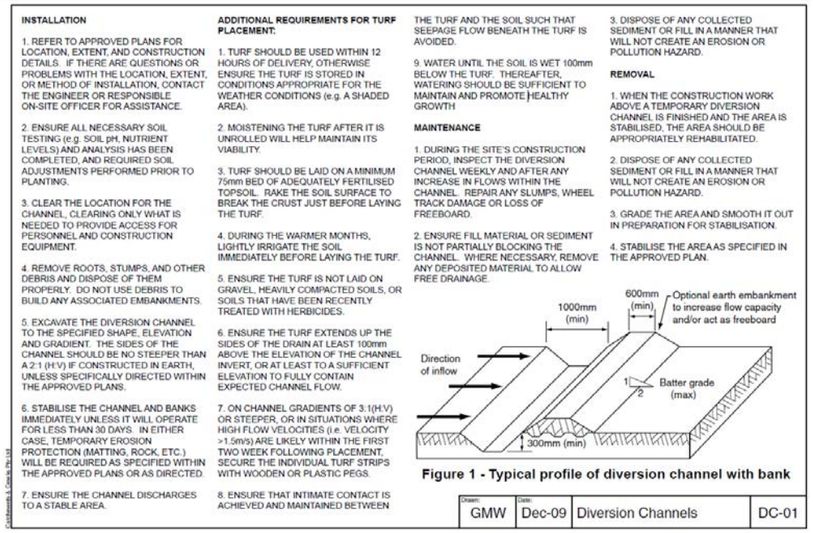
APPENDIX A TYPICAL ESCP DESIGNS

TYPICAL DESIGNS



Note: check dams can also be constructed using sediment bags or coir logs

Figure A. Rock check dam (RCD-01)



INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.
2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.
3. CLEAR THE LOCATION FOR THE CHANNEL, CLEARING ONLY WHAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND CONSTRUCTION EQUIPMENT.
4. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD ANY ASSOCIATED EMBANKMENTS.
5. EXCAVATE THE DIVERSION CHANNEL TO THE SPECIFIED SHAPE, ELEVATION AND GRADIENT. THE SIDES OF THE CHANNEL SHOULD BE NO STEEPER THAN A 2:1 (H:V) IF CONSTRUCTED IN EARTH, UNLESS SPECIFICALLY DIRECTED WITHIN THE APPROVED PLANS.
6. STABILISE THE CHANNEL AND BANKS IMMEDIATELY UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS. IN EITHER CASE, TEMPORARY EROSION PROTECTION (MATTING, ROCK, ETC.) WILL BE REQUIRED AS SPECIFIED WITHIN THE APPROVED PLANS OR AS DIRECTED.
7. ENSURE THE CHANNEL DISCHARGES TO A STABLE AREA.

ADDITIONAL REQUIREMENTS FOR TURF PLACEMENT:

1. TURF SHOULD BE USED WITHIN 12 HOURS OF DELIVERY, OTHERWISE ENSURE THE TURF IS STORED IN CONDITIONS APPROPRIATE FOR THE WEATHER CONDITIONS (e.g. A SHADED AREA).
2. MOISTENING THE TURF AFTER IT IS UNROLLED WILL HELP MAINTAIN ITS VIABILITY.
3. TURF SHOULD BE LAID ON A MINIMUM 75mm BED OF ADEQUATELY FERTILISED TOPSOIL. RAKE THE SOIL SURFACE TO BREAK THE CRUST JUST BEFORE LAYING THE TURF.
4. DURING THE WARMER MONTHS, LIGHTLY IRRIGATE THE SOIL IMMEDIATELY BEFORE LAYING THE TURF.
5. ENSURE THE TURF IS NOT LAID ON GRAVEL, HEAVILY COMPACTED SOILS, OR SOILS THAT HAVE BEEN RECENTLY TREATED WITH HERBICIDES.
6. ENSURE THE TURF EXTENDS UP THE SIDES OF THE DRAIN AT LEAST 100mm ABOVE THE ELEVATION OF THE CHANNEL INVERT, OR AT LEAST TO A SUFFICIENT ELEVATION TO FULLY CONTAIN EXPECTED CHANNEL FLOW.
7. ON CHANNEL GRADIENTS OF 3:1(H:V) OR STEEPER, OR IN SITUATIONS WHERE HIGH FLOW VELOCITIES (i.e. VELOCITY >1.5m/s) ARE LIKELY WITHIN THE FIRST TWO WEEK FOLLOWING PLACEMENT, SECURE THE INDIVIDUAL TURF STRIPS WITH WOODEN OR PLASTIC PEGS.
8. ENSURE THAT INTIMATE CONTACT IS ACHIEVED AND MAINTAINED BETWEEN THE TURF AND THE SOIL SUCH THAT SEEPAGE FLOW BENEATH THE TURF IS AVOIDED.
9. WATER UNTIL THE SOIL IS WET 100mm BELOW THE TURF. THEREAFTER, WATERING SHOULD BE SUFFICIENT TO MAINTAIN AND PROMOTE HEALTHY GROWTH

MAINTENANCE

1. DURING THE SITE'S CONSTRUCTION PERIOD, INSPECT THE DIVERSION CHANNEL WEEKLY AND AFTER ANY INCREASE IN FLOWS WITHIN THE CHANNEL. REPAIR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD.
2. ENSURE FILL MATERIAL OR SEDIMENT IS NOT PARTIALLY BLOCKING THE CHANNEL. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.
3. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE CONSTRUCTION WORK ABOVE A TEMPORARY DIVERSION CHANNEL IS FINISHED AND THE AREA IS STABILISED, THE AREA SHOULD BE APPROPRIATELY REHABILITATED.
2. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.
3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.
4. STABILISE THE AREA AS SPECIFIED IN THE APPROVED PLAN.

Figure 1 - Typical profile of diversion channel with bank

Drawn:	Date:		
GMW	Dec-09	Diversion Channels	DC-01

Figure B. Diversion channel (DC-01)

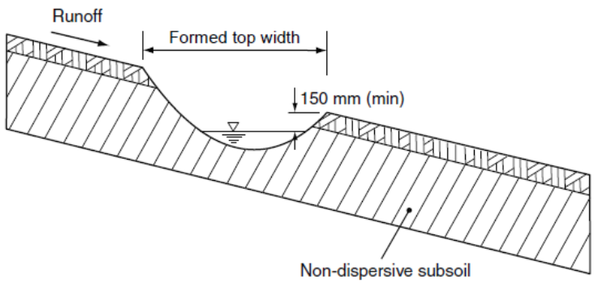


Figure C. Parabolic catch drain (CD-01)

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.
2. CLEAR THE LOCATION FOR THE BANK, CLEARING ONLY THE AREA THAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT.
3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.
4. FORM THE BANK FROM THE MATERIAL, AND TO THE DIMENSION SPECIFIED IN THE APPROVED PLANS.
5. IF EARTH IS USED, THEN ENSURE THE SIDES OF THE BANK ARE NO STEEPER THAN A 2:1 (H:V) SLOPE, AND THE COMPLETED BANK MUST BE AT LEAST 500mm HIGH.
6. IF FORMED FROM SANDBAGS, THEN ENSURE THE BAGS ARE TIGHTLY PACKED SUCH THAT WATER LEAKAGE THROUGH THE BAGS IS MINIMISED.
7. CHECK THE BANK ALIGNMENT TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.
8. THE BANK SHOULD BE VEGETATED (TURFED, SEEDED AND MULCHED), OR OTHERWISE STABILISED IMMEDIATELY, UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS OR IF SIGNIFICANT RAINFALL IS NOT EXPECTED DURING THE LIFE OF THE BANK.
9. ENSURE THE EMBANKMENT DRAINS TO A STABLE OUTLET, AND DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT FLOW DIVERSION BANKS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.
2. INSPECT THE BANK FOR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD. MAKE REPAIRS AS NECESSARY.
3. CHECK THAT FILL MATERIAL OR SEDIMENT HAS NOT PARTIALLY BLOCKED THE DRAINAGE PATH UP-SLOPE OF THE EMBANKMENT. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.
4. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.
5. REPAIR ANY PLACES IN THE BANK THAT ARE WEAKENED OR IN RISK OF FAILURE.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE BANK IS FINISHED AND THE AREA IS STABILISED, THE FLOW DIVERSION BANK SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.
2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.
3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.
4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED IN THE APPROVED PLAN.

Figure 1 - Typical profile of flow diversion bank formed from earth

Table 1 - Recommended dimensions of flow diversion banks

Parameter	Earth banks	Vegetated banks	Compost berms	Sandbag berms
Height (min)	500 mm	500 mm	300 mm	N/A
Top width (min)	500 mm	500 mm	100 mm	N/A
Base width (min)	2500 mm	2500 mm	600 mm	N/A
Side slope (max)	2:1 (H:V)	2:1 (H:V)	1:1 (H:V)	N/A
Freeboard	300 mm	150 mm	100 mm	50 mm

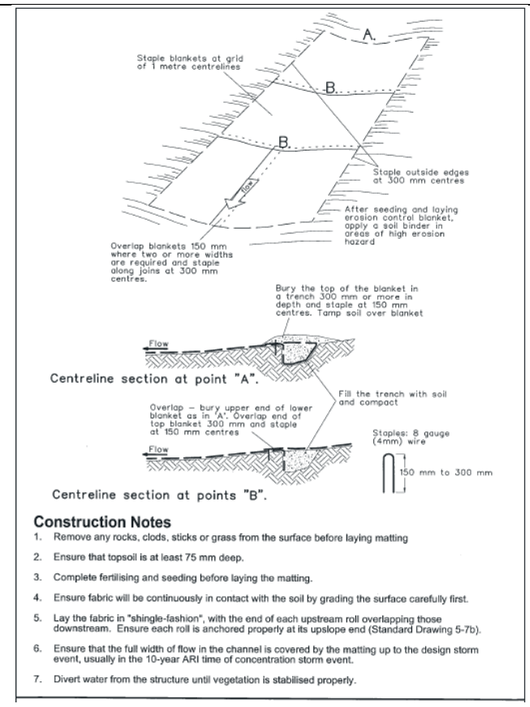
Drawn:	Date:		
GMW	Dec-09	Flow Diversion Banks	DB-01

Figure D. Flow diversion banks (DB-01)

Recommended maximum berm spacing

Land slope	Max spacing
< 2%	30 m
5%	25 m
10%	15 m
20%	8 m

Figure E. Mulch filter berm (MB-01)



Construction Notes

1. Remove any rocks, clods, sticks or grass from the surface before laying matting
2. Ensure that topsoil is at least 75 mm deep.
3. Complete fertilising and seeding before laying the matting.
4. Ensure fabric will be continuously in contact with the soil by grading the surface carefully first.
5. Lay the fabric in "shingle-fashion", with the end of each upstream roll overlapping those downstream. Ensure each roll is anchored properly at its upslope end (Standard Drawing 5-7b).
6. Ensure that the full width of flow in the channel is covered by the matting up to the design storm event, usually in the 10-year ARI time of concentration storm event.
7. Divert water from the structure until vegetation is stabilised properly.

Figure F. Lined chute (IECA 2021)

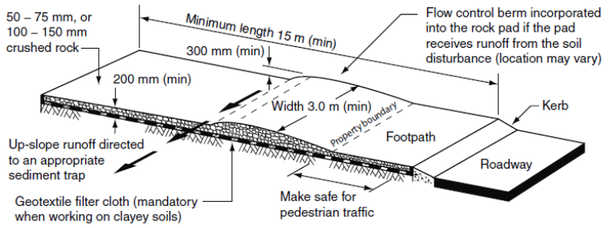
Revision	Date	Drawn	Approved	Description
1	20/07/2022	AF	EL	Issued to client

PREPARED BY: ENVIRONMENTAL CONSULTANTS TERRITORY PROUD (EcOz)

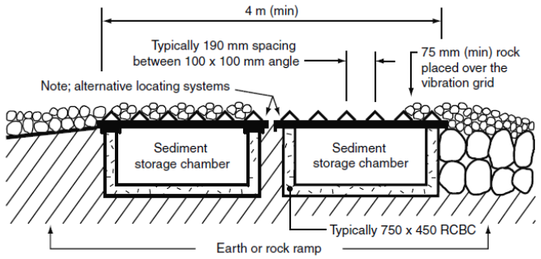
PREPARED FOR: NORTHERN TERRITORY GOVERNMENT

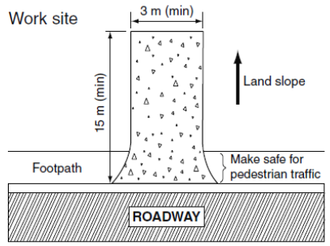
Holtze Residential Development

Primary Erosion and Sediment Control Plan

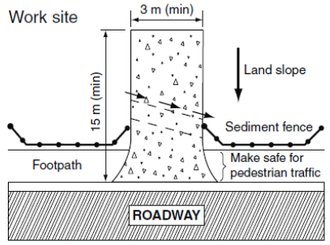


(a) Rock entry/exit pad for construction sites (refer to Standard Drawing Exit-03 for building sites)



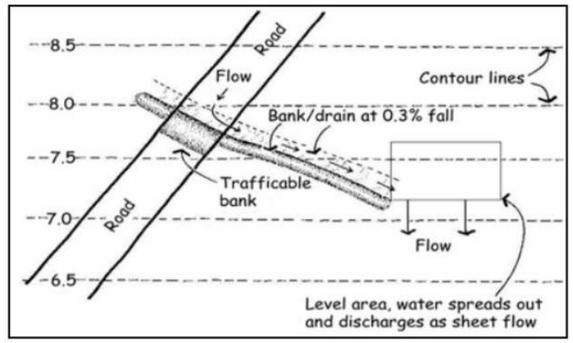


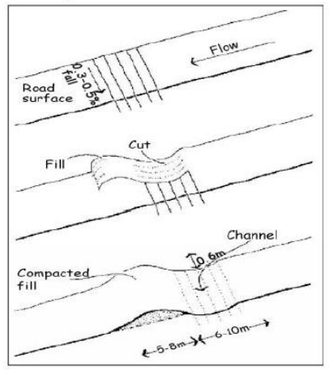
(b) Rock pad sloping away from road



(d) Rock pad sloping towards the road

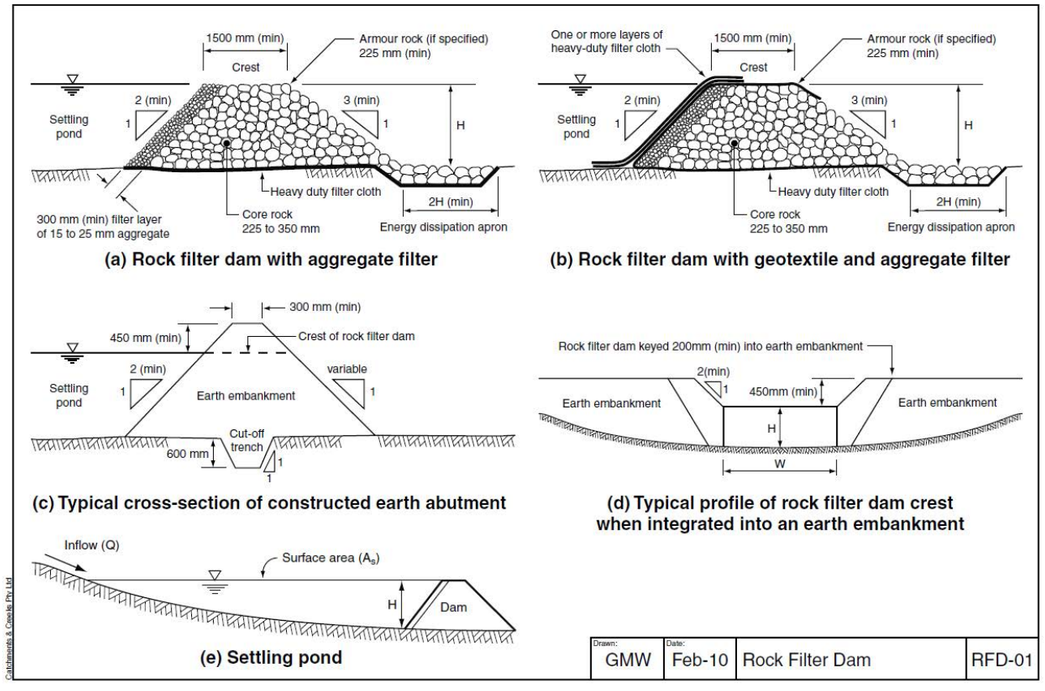
Figure G. Construction exit – rock pad (Exit-01)





Road grade	Cross bank spacing (max)
< 2 %	250
2 – 4 %	200
4 – 6 %	150
6 – 8 %	125

Figure H. Cross bank (whoa-boy) construction (NTG 2021)



MATERIALS

PRIMARY CORE ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, WITH MEAN SIZE AS SPECIFIED IN THE APPROVED PLAN, BUT NOT LESS THAN 225mm, OR GREATER THAN 350mm.

ARMOUR ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, WITH MEAN SIZE AS SPECIFIED IN THE APPROVED PLAN, BUT NOT LESS THAN 225mm.

AGGREGATE FILTER: 15 TO 25mm CLEAN AGGREGATE.

GEOTEXTILE FILTER FABRIC: HEAVY-DUTY NON-WOVEN, NEEDLE-PUNCHED FILTER FABRIC, MINIMUM 'BIDIM' A34 OR EQUIVALENT.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE FOUNDATION AREA OF THE ROCK FILTER DAM OF WOODY VEGETATION AND ORGANIC MATTER. DELAY CLEARING THE UP-SLOPE POND AREA UNTIL THE DAM IS FORMED AND IS ABLE TO ACT AS A SUITABLE SEDIMENT TRAP, OTHERWISE AN ALTERNATIVE TEMPORARY DOWNSTREAM SEDIMENT TRAP MAY BE REQUIRED DURING CONSTRUCTION OF THE ROCK FILTER DAM.

3. IF SPECIFIED ON THE PLANS, EXCAVATE A CUT-OFF TRENCH ALONG THE CENTRE-LINE OF THE DAM AND EARTH ABUTMENTS (IF ANY).

4. COVER THE FOUNDATION AREA AND CUT-OFF TRENCH WITH HEAVY-DUTY FILTER FABRIC BEFORE BACKFILLING WITH THE CORE ROCK. OVERLAP ADJOINING FABRIC SHEETS A MINIMUM OF 600mm.

5. CONSTRUCT THE ASSOCIATED EARTH ABUTMENT (IF ANY). ALL CUT AND FILL SLOPES SHOULD BE 2:1(H:V) OR FLATTER. THE DOWNSTREAM FACE OF EARTH ABUTMENTS SHOULD BE 3:1(H:V) OR FLATTER. EARTH ABUTMENTS SHOULD BE CONSTRUCTED OF WELL-COMPACTED, EROSION RESISTANT SOIL THAT IS FREE OF VEGETATION AND ROOTS. OVERFILL EARTH ABUTMENTS 150mm TO ALLOW FOR SETTLEMENT.

6. PLACE THE CORE ROCK FOR THE ROCK FILTER DAM. ENSURE THE UPSTREAM FACE IS 2:1(H:V) OR FLATTER, AND THE DOWNSTREAM FACE IS 3:1(H:V) OR FLATTER.

7. ENSURE THE ROCK IS MACHINE PLACED WITH THE SMALLER ROCKS WORKED INTO THE VOIDS OF THE LARGER ROCKS.

8. IF SPECIFIED, CONSTRUCT THE SPILLWAY SECTION USING THE SPECIFIED ARMOUR ROCK. THE SPILLWAY SHOULD HAVE A MINIMUM PROFILE DEPTH OF 300mm. THE SPILLWAY WEIR CREST MUST BE LEVEL ACROSS ITS FULL WIDTH. THE MAXIMUM LONGITUDINAL SLOPE OF THE ROCK SPILLWAY SHOULD BE 3:1(H:V). THE MINIMUM THICKNESS OF ARMOUR ROCK PROTECTION SHOULD BE 500mm, OR TWICE THE NOMINAL ROCK SIZE, WHICHEVER IS THE GREATER.

9. ENSURE THE SPILLWAY OUTLET SECTION EXTENDS DOWNSTREAM PAST THE TOE OF THE FORMED EMBANKMENT UNTIL STABLE CONDITIONS ARE REACHED, OR A DISTANCE EQUAL TO THE HEIGHT OF THE DAM, WHICHEVER IS THE GREATER. THE EDGES OF THE SPILLWAY SHOULD BE LEFT FLUSH WITH THE SURROUNDING GROUND.

10. INSTALL THE SPECIFIED FILTER (AGGREGATE AND/OR FILTER CLOTH) ON THE UPSTREAM FACE OF THE ROCK FILTER DAM.

11. IF FILTER CLOTH IS USED, THEN:
(i) EXTEND THE FABRIC OVER THE CREST OF THE ROCK FILTER DAM INTO THE SPILLWAY CHUTE;
(ii) CONSIDER THE PLACEMENT OF SEVERAL LAYERS OF OVERLAPPING FABRIC, THUS ALLOWING EACH LAYER TO BE REMOVED INDIVIDUALLY ONCE THE FABRIC BECOMES BLOCKED WITH SEDIMENT.

12. CLEAR THE SETTLING POND AREA OF WOODY VEGETATION AND ORGANIC MATTER TO THE DIMENSIONS SPECIFIED WITHIN THE PLANS.

13. WHERE NECESSARY, EXCAVATE THE UPSTREAM SETTLING POND AND/OR SEDIMENT STORAGE PIT IN ACCORDANCE WITH THE APPROVED PLANS. EXCAVATED PITS TYPICALLY HAVE SIDE SLOPES OF 2:1(H:V) OR FLATTER UNLESS STEEPER SLOPES ARE KNOWN TO BE STABLE.

14. STABILISE ANY ASSOCIATED EARTH EMBANKMENTS IMMEDIATELY AFTER CONSTRUCTION THROUGH APPROPRIATE COMPACTION, VEGETATION AND/OR EROSION CONTROL MATTING.

15. ESTABLISH ALL NECESSARY UP-SLOPE DRAINAGE CONTROL MEASURES TO ENSURE THAT SEDIMENT-LADEN RUNOFF IS APPROPRIATELY DIRECTED INTO THE SEDIMENT TRAP.

16. TAKE ALL NECESSARY MEASURE TO MINIMISE THE SAFETY RISK CAUSED BY THE STRUCTURE.

MAINTENANCE

1. CHECK ALL ROCK FILTER DAMS AFTER EACH RUNOFF EVENT AND MAKE REPAIRS IMMEDIATELY.

2. INSPECT ALL ROCK AND EARTH EMBANKMENTS FOR UNDERCUTTING OR UNDESIRABLE SEEPAGE FLOWS.

3. IDEALLY, ROCK FILTER DAMS SHOULD DISCHARGE (FROM FULL) OVER NO LESS THAN 8 HOURS. IF DRAINAGE IS TOO RAPID, THEN ADDITIONAL FILTER AGGREGATE MAYBE REQUIRED TO ACHIEVE OPTIMUM HYDRAULIC PERFORMANCE.

4. IF FLOW THROUGH THE STRUCTURE IS REDUCED TO AN UNACCEPTABLE LEVEL, THE UPSTREAM FILTER MEDIUM (AGGREGATE OR FILTER CLOTH) SHOULD BE REMOVED AND REPLACED.

5. IF A GREATER DEGREE OF WATER TREATMENT (FILTRATION) IS REQUIRED, EXTRA GEOTEXTILE FILTER FABRIC SHOULD BE PLACED OVER THE UPSTREAM FACE OF THE STRUCTURE.

6. CHECK THE STRUCTURE AND DOWNSTREAM CHANNEL BANKS FOR DAMAGE FROM OVERTOPPING FLOWS. MAKE REPAIRS AS NECESSARY.

7. IMMEDIATELY REPLACE ANY ROCK DISPLACED FROM THE SPILLWAY.

8. REMOVE SEDIMENT AND RESTORE ORIGINAL SEDIMENT STORAGE VOLUME WHEN COLLECTED SEDIMENT EXCEEDS 10% OF THE SPECIFIED STORAGE VOLUME.

9. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. WHEN THE UP-SLOPE DRAINAGE AREA HAS BEEN STABILISED, REMOVE ALL MATERIALS INCLUDED DEPOSITED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

2. ALL WATER AND SEDIMENT SHOULD BE REMOVED FROM THE SETTLING POND PRIOR TO THE DAM'S REMOVAL. DISPOSE OF SEDIMENT AND WATER IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. BRING THE DISTURBED AREA TO A PROPER GRADE, THEN SMOOTH, COMPACT AND STABILISE AND/OR REVEGETATE AS REQUIRED TO MINIMISE THE EROSION HAZARD.

Drawn: GMW | Date: Apr-10 | Rock Filter Dam | RFD-02

Figure I. Rock filter dam construction (RFD-01/02)

Revision	Date	Drawn	Approved	Description
1	20/07/2022	AF	EL	Issued to client

PREPARED BY: EnvironmentalConsultants Territory Proud

PREPARED FOR: Northern Territory Government

Holtze Residential Development

Primary Erosion and Sediment Control Plan

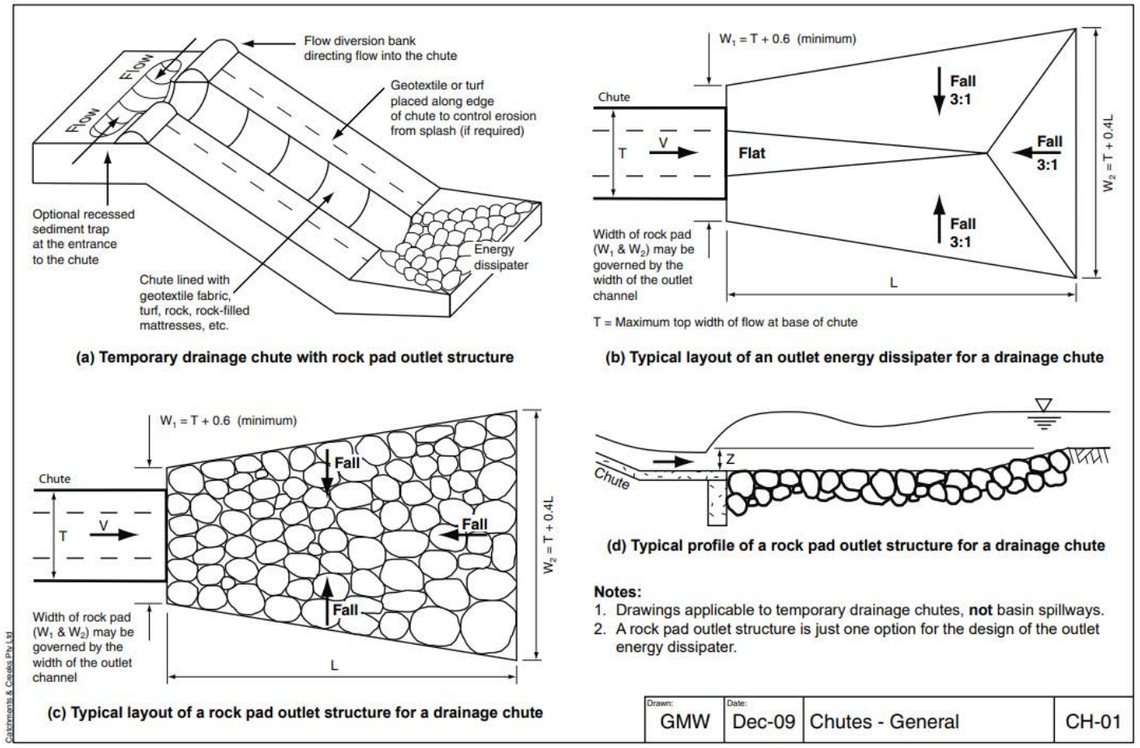


Figure J. Typical chute design (CH-01)

Revision	Date	Drawn	Approved	Description
1	20/07/2022	AF	EL	Issued to client

PREPARED BY: EcOz ENVIRONMENTAL CONSULTANTS TERRITORY PROUD

PREPARED FOR: NORTHERN TERRITORY GOVERNMENT

Holtze Residential Development

Primary Erosion and Sediment Control Plan

APPENDIX B INSPECTION PROFORMA

Erosion & Sediment Control Checklist

Conducted by: **Date:**

Location / Area: **Supervisor:**

Priority:
1. Stop work
2. Fix immediately
3. Fix within 12 hrs
4. Fix within 24hrs
5. Fix within 48hrs
6. Fix within 72hrs

ITEM	STATUS Y/N/NA	COMMENTS	PRIORITY
Summary			
Work footprint minimum extent necessary			
Erosion and sediment controls installed consistent with ESCP			
Erosion and sediment controls functional and effective			
Clean and dirty water adequately separated			
Site being progressively stabilised			
No evidence of off-site sediment, scouring, erosion or pollution			
Planning & Site Establishment			
ESCP is current and applicable to stage of works			
Foremen/Supervisors are aware of ESCP requirements			
Workforce deemed competent in ESC installation (VOC)			
ESC locations marked out prior to installation			
ESCs installed outside of 20yr ARI flood level			
ESCs installed and functional prior to commencement of bulk earthworks			
Work areas and no-go zones cleared delineated			
ESCP requirements clearly communicated to the workforce (eg. Toolbox)			
Erosion Control			
Clearing/disturbance minimum extent necessary for construction			
High traffic areas, laydowns, ancillary areas protected with hardstand surface			
Temporary erosion control materials on hand in case of emergencies			

ITEM		STATUS Y/N/NA	COMMENTS	PRIORITY
Site access				
Site access & egress points stabilised				
Exit points free of sediment/mud tracking				
Construction access able to utilise existing tracks				
Site access tracks stabilised to prevent erosion				
Watercourse crossings installed as per approved design				
Revegetation				
Soil surface sufficiently prepared & roughened prior to seeding				
Date of seed application	How was it applied			
Species	Rate			
Fertiliser Type	Fertiliser Rate			
Assessed % Groundcover				
Hydromulch				
Mulch cover > 80% of the bare ground				
Mulch secured against wind/rain				
How long is material expected to control erosion				
Soil binder				
Type of material used				
Application density				
Date of application				
Expected lifespan (provide > 80% cover)				
Surface currently stable				
Dust				
Dust suppression being carried out				
Appropriate traffic controls in place (eg. speed, restricted)				

ITEM	STATUS Y/N/NA	COMMENTS	PRIORITY
Drainage Control			
Diversion drains/structures - clean water			
Clean water diverted around work area			
Sediment control structure designed to include clean water			
Clean water diversion protected against erosion			
Clean water diversion constructed to control and divert design flows			
Clean water diversion includes stable outlet			
Clean water diversion stable and functional			
Diversion drains/structures - dirty water (sediment laden diversion)			
Dirty water directed to sediment control device			
Dirty water diversion constructed to control and divert design flows			
Dirty water diversion protected against erosion (>5% grade)			
Dirty water diversion includes sumps or check dams			
Dirty water diversion includes stable outlet			
Dirty water diversion stable and functional			
Drop structures/inlets & flumes			
Designed and implemented as per ESCP			
Structure includes stabilised apron (1m) inlet & cut-off trench			
Structure includes stabilised dissipation area			
Correct sized rock being used (no significant movement)			
Water flows down centre of structure (no outflanking)			
Drop structure stable & functional			
Crossings			
Watercourse crossings installed as per the ESCP			
Crossings stable & functional			

ITEM	STATUS Y/N/NA	COMMENTS	PRIORITY
Check Dams			
Correct sized rock being used (no significant movement)			
Water flow over the middle instead of around the edges			
Sediment accumulation < 25% of check dam capacity			
Accumulated sediment disposed of in designated area			
Cut-off (Contour) Drains - dirty water			
Installed and functional (short-term temp structures)			
Graded < 2% (unless lined)			
Min size: 500mm depth; 250mm compacted bank			
U-shaped or parabolic or trapezoidal profile (not V-shaped)			
Catchment area < 0.5ha			
Discharge to sediment control via stable outlet			
Sediment Control			
Sediment Basins			
Sediment basins installed and functional as per design:			
primary spillway installed and functional			
emergency spillway sized for 50yr ARI storm event			
inlet protection (chute)			
3:1 length/width ratio			
sediment storage zone market installed			
internal baffles			
chemical treatment systems			
As-built surveys completed			
Desilting required (sediment capacity > 25%)			
Disposal location identified for desilt material			

ITEM	STATUS Y/N/NA	COMMENTS	PRIORITY
Type 2 and 3 controls			
Installed and functional as per design			
Desilting required (sediment capacity > 25%)			
Stockpiles			
Stockpiles located minimum of 50 meters from water bodies and drains			
Stockpiles protected/stabilised			
Dewatering			
Dewatering of excavations required			
Permit in place for all dewatering activities			
Dewatering in accordance with procedure and permit conditions			
Groundwater intercepted within excavations			
Pollution Control			
Concrete washouts in place and being used			
Concrete washouts have sufficient capacity			
Hazardous substances stored in bunded areas (including fuel)			
Ancillary equipment (pumps, generators etc) stored and operated in bunded areas			
Refuelling in accordnace with refuelling procedure			
Spill kits available within work area			
Spill kits fully stocked			

Additional Comments:

Inspection Conducted By:

Site Personnel's Name & Signature:

ITEM	STATUS Y/N/NA	COMMENTS	PRIORITY

SUMMARY OF ACTIONS

ITEM	LOCATION	ACTION	RESPONSIBILITY	DUE DATE	CHECKED	
					NAME	DATE

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